

# Knowledge transfer model for agricultural engineering

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**Abstract:** Farmers need proven and new knowledge of engineering matters to solve technical problems and manage technical investments in their agricultural business. According to the recent budget restriction, the Bavarian state aims in the future to be involved in providing only those goods and services which the private sector is not willing to provide. The overall aim of this paper is the identification of a model which guarantees an effective and uninterrupted knowledge transfer, despite restricted resources. An important aspect of knowledge transfer in Agricultural Engineering is the missing availability of advice in engineering for farmers in the private sector. The sources used for identifying adequate transfer models were the literature, existing models of advisory systems, expert panels, and questioning of selected actors in the existing knowledge transfer system. The relevant criteria for developing a model is the limited number of public consultants, the farm-related amount of investments in sustainable farm businesses, key competences of Bavarian farms, the demand for advisory services of the majority of farms, and the possibilities of a work-sharing cooperation between public and private advisory services. In this model, public consultants have to act as supra-regional multipliers, as knowledge engineers, they identify and provide relevant new expert information and expert knowledge for advisers in the regions, farmers and other demanders in time. Other identified instruments for efficiency increase in knowledge transfer are the shortening of knowledge transfer ways, application of new information and communication technologies, and reorganisation according to communication channels. External communication can be improved by networks between actors in knowledge transfer and timely consultant profiles, next to the cooperation possibilities with private advisory organisations and the building-up of demand-oriented core capabilities.

**Keywords:** knowledge transfer, advice, modelling, reorganisation, multiplier, cooperation

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## 1 Introduction

As part of its budget consolidation measures, Bavaria plans to cut its budgets for advisory services by 44% in the next year, and to reduce the services' field of action to administrative and public welfare tasks. Bavaria's agriculture is marked by its system of small farming businesses, which currently consists of 121,659 farms (Bayerisches Staatsministerium für Landwirtschaft und Forsten, 2008). Their farm managers need technical information and engineering knowhow from consultants and the media to identify and solve individual agricultural and structural engineering problems. This demand

increases with social change and technological progress. Advisory services on agricultural and structural engineering have been reduced by around 30% in the last three years, from 23 to 17 manpower units per specialist field (consultants in agricultural and structural engineering). Consultants in agricultural and structural engineering operate on a supra-regional basis and provide their services to farmers from two to three districts.

If the recent downward trend in the number of farms continues, there will be a further decrease of 35% in the number of farms in the coming 15 years, as estimated by Goldbrunner (2007) (Bayerisches Staatsministerium für Landwirtschaft und Forsten, 2008). An aliquot reduction in the demand for information and advisory services could not be detected, since individual demand has been rising. Within a period of 20 years, and considering the decrease in the number of farms, only 6.8

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manpower hours of each specialist field, including preparation and travel time, are available per farm.

It is assumed that the demand for information and knowledge at the operational level is constantly increasing because of the rapid growth in data and knowledge, shorter production cycles, and greater sophistication in management necessitated by new technologies and requirements (traceability, quality assurance, environmentally friendly production, etc.) (Stricker et al., 2001 Herd et al., 2007). However, it is estimated that only 10% of the knowledge generated in agricultural engineering each week – the equivalent of about 250 pages – finds its way into practice and teaching.

The entire knowledge transfer between practice and research has been identified as a cycle consisting of an objectification and a subjectification phase (Quendler, 2009). The objectification phase includes the stages of a research strategy that leads to an objective scientific result which cannot be applied immediately by an individual farmer. This fact necessitates a subjectification phase in which the new knowledge is prepared by an agricultural engineering consultant for the practitioner (farmer) and for the practical demands of the region. According to Bertram (2006), this task is incumbent on the advisory services, and the quality of their work consists in specialist and regional expertise, as well as in being the mediator between the sciences, industry, and practice. However, due to the small number of consultants, a bottleneck situation for the transfer of agricultural engineering knowledge exists. Therefore, research objectives aim to create a transfer model that, despite scarce resources, helps to make suitable knowledge in agricultural and structural engineering available through different media and multipliers at the right time and the right place in an efficient way. It requires the identification of the knowledge transfer actors with their advice supply, structures, resources and demands (in qualitative and quantitative terms) of the present and the future to improve the model based knowledge transfer service by low costs.

## 2 Materials and methods

The material basis of the knowledge transfer system developed here was Bavaria's agricultural system and the future reduction in advisory services available. To identify the characteristics of the most important actors and compensation possibilities of Bavaria's agricultural system, the knowledge transfer approach was chosen. The operations defined the behaviour of the actors in the transfer system of agricultural and structural engineering knowledge, expressed by knowledge-based functions.

The knowledge demand was represented by the number of farm businesses, as well as their fundamental business parameters for the demand for agricultural and structural engineering knowledge. As regards knowledge supply, the providers of agricultural and structural engineering knowledge within the existing knowledge transfer system had to be determined and their competences evaluated. The most important criteria for this evaluation were the number of consultants, their focus, the consultancy methods, the organisational structure, their financial sources, and their relation to other market participants. The methods used for identifying and assessing these criteria were literature research, surveys, and discussion in working groups.

The model was developed to describe the knowledge transfer system in agricultural engineering, including relevant system elements and contexts, in a coherent, clear, and illustrative way. The issues were categorised, and the system was illustrated by relevant system elements in a function- and the data-oriented way (Bernoider and Stix, 2004).

Analogies and associations were presented in relation to the current situation of advisory services and knowledge transfer of other fields and in other European countries, with special attention to the difference between small and large agricultural systems (Sell and Schimweg, 1998).

Compensation measures and the impact of scarcer capacities in advisory services in the field of agricultural and structural engineering on knowledge transfer were categorised and assessed both deductively and inductively. To do so, a SWOT analysis, a strategic planning method

used to evaluate the strengths, weaknesses, opportunities and threats, and the expertise of interdisciplinary working groups consisting of up to 25 experts were applied (Wagemann, 2004).

To optimise the monetary and user-oriented effects for the advisory system, agriculture, and economy, a survey among farmers and a cost-benefit analysis for the public agricultural advisory service system were conducted. The costs and benefits of labour and infrastructure of the consisting advisory service system were compared with the costs and benefits of the information and communication oriented advisory service system model, including knowledge management, which is a partial part of the created knowledge transfer model. For an objective comparison, a discount rate of 8%, taken from the financial market, was chosen to compute all relevant future costs and benefits in present terms. The partial results were constantly validated, verified, and revised in working groups in order to use them for developing the optimum knowledge transfer model.

### 3 Results and discussion

#### 3.1 Knowledge supply and demand

In order to develop a model that adequately shows the requirements of the future knowledge transfer in agricultural and structural engineering and the efficient allocation of scarce budget resources, the current system with its actors and future trends must be assessed. These aspects are necessary to quantify and evaluate future demand and supply, including the consideration of efficient transfer ways, organisational structures, and funding possibilities.

#### 3.2 Provision of agricultural and structural engineering expertise

The number of actors, as well as their behaviour, was a relevant key criterion for the reorganisation of parts of the knowledge transfer in agricultural engineering to improve efficiency and effectiveness (Figure 1). By means of a SWOT analysis, the actors' organisational structure, thematic focuses, and their competences were assessed (Wagemann, 2004).

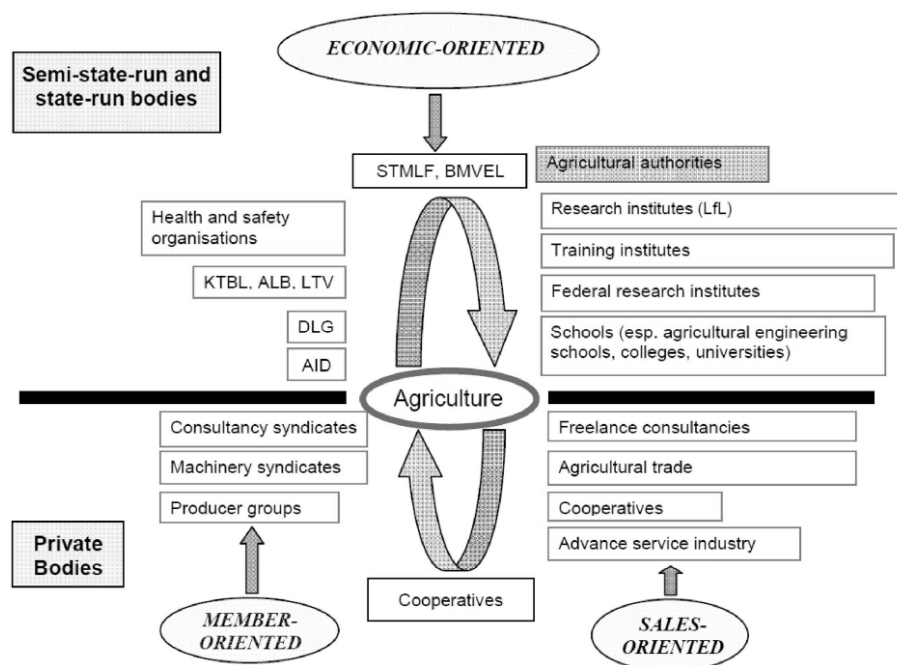


Figure 1 Institutions for knowledge transfer in agricultural and structural engineering (authors' own illustration)

Besides official advisory services, universities, research institutes, training institutes, providers of national insurance, and state-funded specialist associations (KTBL, AID, etc.) were identified as state-run and semi-state-run bodies of knowledge transfer. Their major aim is to

research and prepare objective, collective knowledge. Non-state-run bodies of knowledge transfer are freelance consultancies; sale-oriented consultancies (sales pitch) of the agricultural machinery trade, of the cooperatives, and of the advance service industry; service-based machinery

syndicates and member-oriented consultancy syndicates; producer groups; and inspection cooperatives. They all communicated both explicit and implicit specialist knowledge. Differences between those actors, identified by means of a SWOT analysis, were found in their organisational structure, content and amount of information for consultancy purposes, focus and methodology of consultancy service, quality, neutrality, credibility, costs, and local presence. The higher the degree of privatisation, the higher the costs, the sales-oriented behaviour, and the specialisation in the chosen field, but the lower the consideration of consultancy contents geared towards the public interest and the local presence.

### 3.3 Demand for information and advisory services

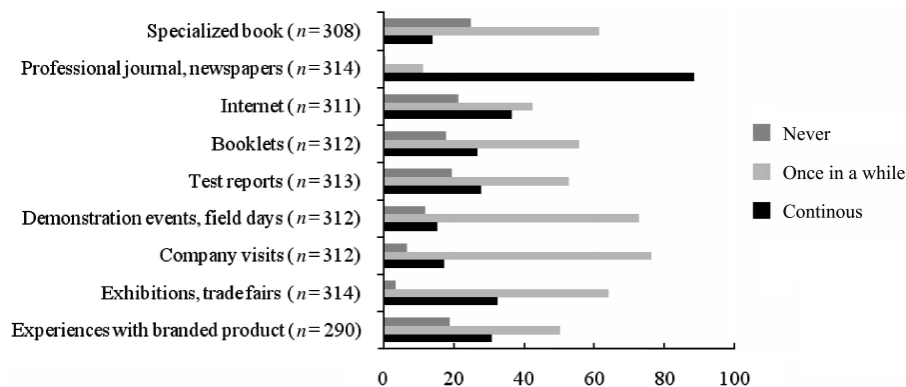


Figure 2 Information sources and their use intensity in percent of questioned farmers ( $n = 290 - 314$ )

The majority of farmers regularly used specialist magazines, newspapers, and consultancy services and found their information most credible and neutral. To acquire information and make sustainable investment decisions, a third used the internet, experiences with the branded product, trade fairs, exhibitions, and test reports, which they considered to be averagely neutral and credible. Farmers mainly used the internet to find additional expert information, as well as information on machinery, equipment, and structural solutions. Because of its confusing arrangement, unsatisfactory quality and quantity, especially regarding company details, however, this information was not sufficient enough for facilitating good decisions in issues of agricultural and structural engineering. All of the surveyed farmers showed a readiness to use new information and communication technologies to meet

The surveyed farmers whose businesses were growing consume agricultural and structural engineering information and knowledge to keep abreast of the latest developments, to solve short- and long-term problems, and to take investment decisions that may determine their existence. The majority of surveyed farmers in the German federal states of Bavaria and Brandenburg attached great importance to structural engineering and medium importance to machinery and equipment (Bokelmann et al., 1996; Quendler, 2009).

The most important sources of information (Figure 2), continuous or once in a while used, were specialist and advertising media, events, company visits, field days and experiences with the branded product, and consultancy services.

their company's communication and information needs. They expressed great interest in having access to pre-selected digital specialist information. The expected advantages were saving time when searching for information, having ready access to information, finding clearly arranged and compact information, and requiring less expert advice, also by reducing the time needed for consultation because the farmers already acquired good knowledge through other channels.

Events where new machinery and equipment were demonstrated, company visits, and reference books were used regularly marginally and frequently for major investment decision-making. The credibility and neutrality of advertising brochures were thought to be very low. Boland and Schwarte (2001) found similar tendencies in the information behaviour of Hessian farmers (24f). The official advisory services were

thought to be particularly neutral and credible. When planning technical and structural investments, 87% of the surveyed farmers used these services, because the planned investments were capital intensive and irreversible.

However, the official advisory services covered less than one-fifth of the demand for advice on technical issues and nearly 50% of the demand in structural matters for solving short and long term problems. Member organisations covered only one-tenth of the demand for advisory services on questions regarding agricultural and structural engineering. The credibility and neutrality of their service were estimated as medium to high. Although these organisations lacked comprehensive expert knowledge in agricultural and structural engineering, they boasted a very good regional network and offered specialised fee-based advisory service in selected fields. Such organisations also allowed greater specialisation to achieve a higher level of comprehensiveness and to expand the fee-based consultancy modules to include individual, profit-oriented advisory services.

The trade and the cooperatives met 59% and 36% of the demand for advisory services in agricultural and structural engineering. It was important to note that these were sales-oriented consultancy service providers whose credibility and neutrality were both estimated as low. With less than 10%, the contribution of private consultants to covering the demand for advisory services was rather meagre (Figure 3) (Quendler, 2009).

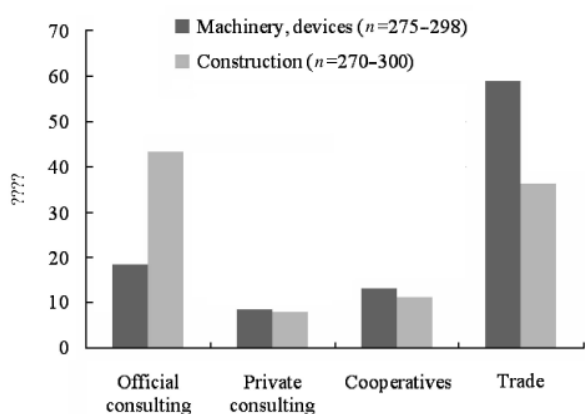


Figure 3 Advice demanded by providers in percent of questioned farmers ( $n=270-300$ )

Managers of growing farming businesses in Bavaria still used advisory services from a consultant mainly for acquiring information and finding solutions. In future, this service form will only play a minor role; the individualised service of a coach that supports the farm management in a process- and relational-oriented way will be required (Boland and Schwarte, 2001).

To strengthen these aims despite scarce resources, the more efficient and less expensive working groups with new information media should be used in place of individual consultations. For this reason, consultants had to become more specialised in core areas and enhance their soft skills. Furthermore, it was necessary to encourage interdisciplinary cooperation and teamwork and implement efficient information systems and structures.

The surveyed Bavarian and Hessian farmers did not show much willingness to finance advisory services; as they depended largely on individual benefit, it was likely that these services could be realised in economic and technological areas. In recent decades, European countries which used to have large farming businesses saw great privatisation. In consequence, as the number of small businesses grew, the supply of advisory services decreased. Private consultancy organisations particularly neglected advisory services on public interest and agro-political issues if government intervention was not possible (Garforth, 2002; Platen, 2008). In future, economic issues will increase in significance, which is why they have to be covered by consultancies on behalf of and with financial help from the government.

As they guaranteed high neutrality and a good regional network at low costs, member organisations seemed to be the best suitable as the cooperation partner of state-run advisory services. As a result, not only will the financial situation be improved, but also the exertion of political influence, the steering of the consultancy service (determining core competences, quality), and the implementation of economic goals will be ensured.

Special tasks in agricultural and structural engineering (preparation of specialist knowledge (documents, print material), training and further education of farmers and consultants, solving intricate problems) could be executed

by state-run consultancies financed by the government. Operational fee-based advisory services could be offered to the farmers directly by consultants that cooperate with the state-run service. The specialist consultants act supra-regional as multipliers, as knowledge engineers, while the local consultants function as knowledge analysts within the knowledge transfer of agricultural and structural engineering.

The largest economic benefit can be achieved with reduced state-run consultancy services if they can provide satisfactory service on contents of public interest required by large businesses, which have a high demand for investments and advice on their specific problems.

Providing knowledge in agricultural and structural engineering in order to ensure the smooth operation of a farming business's specific production technology could be done by sharing consultancy tasks with other market participants. Specialist consultants, who gain and enhance their knowledge of agricultural and structural engineering in training courses (held by consultants in agricultural and structural engineering), could provide their coach-like service directly on the farms (Quendler, 2009).

### 3.4 Bavaria's knowledge transfer model

The model developed on the basis of the above findings (Figure 4) aims at a closer knit network of the

advisory services run by the state and by the member organisations, as well as a digital pre-selection of specialist information through knowledge engineers and shorter transfer ways. A communication-oriented administration structure, including knowledge management, will intensify knowledge transfer at lower costs.

Farmers can access a large amount of information and knowledge in digitalised form free of charge (internet portal, search engine, etc.). If farmers need individualised advice for their decision-making, they can contact local consultants (knowledge analysts) working with the member organisations in their region via a central contact or call centre. If specific problems cannot be solved with the help of the local consultants, the specialist consultants of the public authorities (knowledge engineers, multipliers) will step in. The differentiation between specialist consultant and local consultant also creates different requirements regarding their training and the personnel costs. Because of the application of modern information and communication technologies, fewer offices are needed and more flexible jobs, whose infrastructure is less cost intensive, can be created.

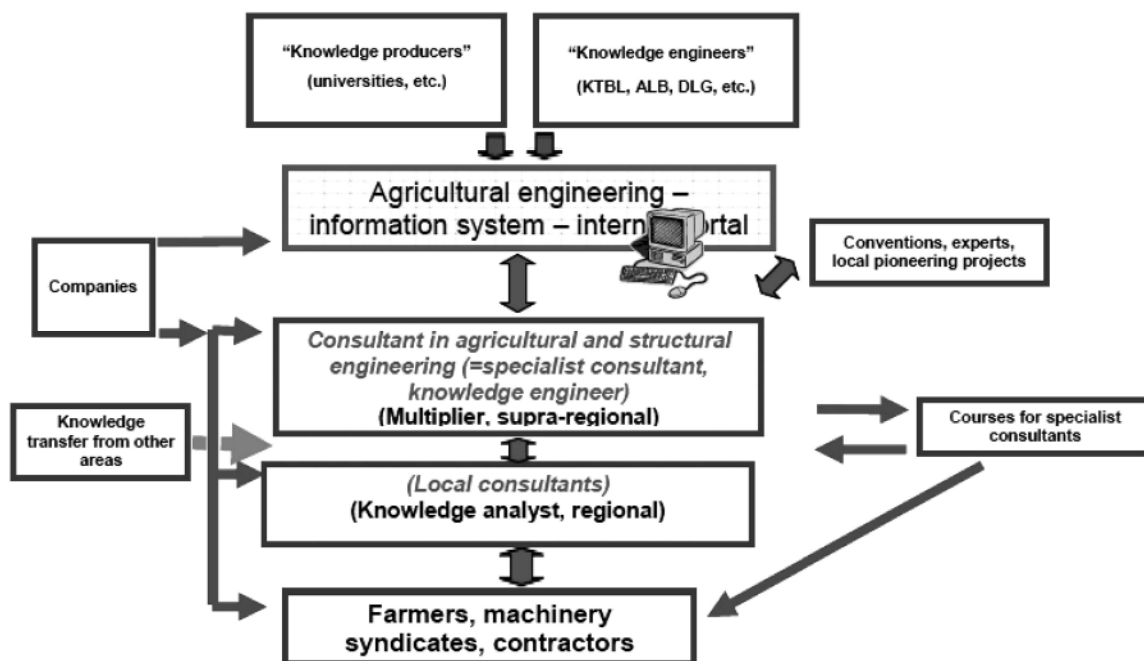


Figure 4 Knowledge transfer model for agricultural and structural engineering in Bavaria

The first cost-benefit results for a restructured advisory service system, based on the above results and assumptions, showed that by reorganising the existing communication channels and employing modern information and communication technologies, a gradual reduction in personnel and infrastructure costs could be achieved.

The analysis considered offering more advice via internet and e-mail, for groups and over presentations which allowed a reduction in the cost intensive individualised advice via post, phone, at the farms and in the advice offices by up to 50% without losing in knowledge transfer quality. This procedure enables a reduction in working time hours of around 25% or by 82 consultants and in their infrastructure related, compared with the current situation. Additionally, the local consultants have a lower earning related to their lower qualification of 20% and need only half of the office infrastructure, achieved by desk sharing and mobile working in the regions.

While the costs for the reorganisation (change in organisation, IT equipment, IT personnel, training, maintenance, editors, consultants) of the advisory services system (of all specialist areas of agriculture) are €13 million, the amount that can be saved in personnel, office space, material, and infrastructure costs are three times as high, i.e. €35.3 million. Thus, a capital value of €10.8 million and a return on investment of 20.9% will be achieved over five years. Assuming a reduction in the number of consultants by 15% lead to a capital value of €7.5 million and a return on investment of 17.3% for the same period.

The introduction of the shared advisory services, embodied in Bavaria's Agrarwirtschaftsgesetz (Agriculture Act) of 2008, and of government funds supporting farmers' usage of those advisory services were the first measures of this newly developed model to be implemented. The state is still responsible for the management, training, and core competences related to issues of public interest, as well as for questions regarding economic processes and production technology. The private partners offer farm managers individual fee-based advisory services (specialist information) in

form of modules, while state-run advisory services remain free of charge. The advisory services that farmers receive from private consultants will be subsidised by the state by up to 50% (Bayerisches Staatsministerium für Landwirtschaft und Forsten, 2008). It is expected that this will increase the acceptance and usage of private fee-based consultancy services among small and medium-sized farming business.

## 4 Conclusions

The presented model was developed according to the specific requirements of one region. To develop a distinct system and to simulate future conditions, the findings drawn from literature research, discussions among experts, and SWOT analyses were used as analytical aids.

The description of the agricultural knowledge transfer with its actors and characteristics helped to identify the importance of neutral advisory services for a farm's subjectification and effective possibilities of first compensation measures for reduced consultancy capacities. These measures include the closer knit network and cooperation of regional consultancy organisations, the usage of synergies, and the application of modern information and communication technologies for the provision and transfer of expert knowledge.

The SWOT analysis yielded that the existing knowledge transfer's weakness was the cooperation partners' lack of advisory services in agricultural and structural engineering. Other disadvantages were the supra-regional organisational structure of the advisory services in agricultural and structural engineering, the increasing demand for specialist advisory services, and the lack of information provided in digital form. One solution was found in the increasing usage of new digital media, which enables the creation of new knowledge-oriented consultancy services and smoother communication-oriented administration processes. As the willingness to pay for consultancy services was rather low, profit-oriented private consultancy services and investment incentives were included only in the introductory phase. The cost-benefit analysis showed that this knowledge transfer model was very viable.

Overall, it can be concluded that the development of the model required an intensive analysis of the existing system. Weaknesses and knowledge-based bottlenecks for actors in the knowledge transfer system of agricultural

and structural engineering could be identified faster and sustainable recommendations for further development could be deduced.

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